

## PATENT ABSTRACTS OF JAPAN

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## (54) ORGANIC EL ELEMENT

## (57)Abstract:

PROBLEM TO BE SOLVED: To realize an organic EL element which enables to achieve reliability of thermal stability and the like and high efficiency in the high brightness region at the same time by doping a triplet luminous material in an organic host material, particularly, in a non-conjugated unsaturated polymer.

SOLUTION: The organic EL element comprises a hole injecting electrode, an electron injecting electrode and a luminous layer composed of an organic host material and a dopant disposed between these electrodes. The above organic material is made of a non-conjugated unsaturated polymer material and the above dopant is made of an organic metal complex capable of phosphorescence from a triplet state and contains at least a metal ion belonging to the VII family of the Mendeleyev periodic table.

## LEGAL STATUS

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converted registration]

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CLAIMS

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[Claim(s)]

[Claim 1] It is the organic EL device which is the organometallic complex [ have a hole impregnation electrode, an electron injection electrode, and the luminous layer that becomes inter-electrode / these / from an organic host ingredient and a dopant, and said organic materials are disconjugation polymeric materials, and ] for which said dopant can phosphorescence emit light from 3-fold term condition, and contains the metal ion which belongs to the VIII group of the MENDEREEFU periodic table at least.

[Claim 2] Said host ingredient is the organic EL device of claim 1 which has a carbazole radical.

[Claim 3] The organic EL device of claims 1 or 2 with which said organic host ingredient has hole transportability.

[Claim 4] Said metal ion is one organic EL device of claims 1-3 which are iridium or platinum.

[Claim 5] One organic EL device of claims 1-4 whose energy gaps (Eg) of said organic host ingredient are 2.4eV or more.

[Claim 6] One organic EL device of claims 1-5 which have an electrode interface reforming layer between said luminous layers and one electrodes.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the organic EL device which has luminescence and the display function by electroluminescence (EL) using an organic material.

[0002]

[Description of the Prior Art] An organic EL device uses low-molecular hole transportability ingredients, such as hole impregnation electrode triphenyl diamine (TPD), as a thin film with a vacuum deposition method etc. With the component which has the basic configuration which carried out the laminating and formed the metal electrode with still smaller work functions, such as Mg, (electron injection electrode) on it by making low-molecular fluorescent materials, such as an aluminum quinolinol complex (Alq3), into a luminous layer They are thousands to tens of thousands cd/m2 at the electrical potential difference before and behind 10V. It is observed by very high brightness being obtained.

[0003] On the other hand, the organic EL device using polymeric materials is also reported. By using polymeric materials, improvement in the thermal stability which poses a problem with a \*\*\*\*\* ingredient, simplification of the process by spreading, etc. are attained, and researches and developments are prosperous centering on the West.

[0004] A macromolecule organic EL device can be divided roughly into pi conjugation mold which used the conjugation macromolecule, and the molecular dispersion mold which distributed coloring matter in the disconjugation macromolecule. pi conjugation mold has mainly been studied centering on the West since the announcement (541 Nature 347,539- 1990) by Cambridge University, and creation of the component of high brightness which matches a low-molecular vacuum evaporatio system a decade ago in current is also attained. However, the ingredient of pi conjugated system is thousands - tens of thousands cd/m2 conversely, although it is fundamentally possible to make a current emit light on a low electrical potential difference since it is a sink and a cone ingredient. The effectiveness in the said high brightness field is low, and is intense. [ of generation of heat ] For this reason, it is difficult to use for the PASSHIPU matrix display for which a duty (Duty) drive is needed.

[0005] On the other hand, although 1883 (754 Polymer, Vol, 24,748- 1983) and the report of the molecular dispersion mold were historically long early, as compared with the low-molecular mold and pi conjugation mold, only the property of or less 1/10 extent was acquired.

[0006] By the way, the fluorescence from luminescent material is used in the conventional organic EL device. When an ingredient is in an excitation state, in order that a singlet state may occupy, and a triplet state may occupy 75% 25%, in the conventional organic EL device, the energy of a triplet state serves as heat and does not contribute to luminescence.

[0007] The attempt in which the energy of this triplet state will be used for EL luminescence is performed by Hoshino etc. (Appl.Phys.Lett.69,224-226 (1996)). Furthermore, the more efficient component is created by the group of Princeton University (154 Nature 395,151- 1998). It is reported that the component using this triplet luminescent material shows one several times the brightness of this and effectiveness compared with the organic EL device using luminescence only from the conventional singlet. however, since it is the complicated component configuration which cannot take dependability, such as thermal stability, since it is the component created by the vacuum deposition using a low-molecular ingredient, a process is complicated -- etc. -- a problem is unclearable.

[0008]

[Problem(s) to be Solved by the Invention] The purpose of this invention is realizing the organic EL device which

enables efficient-ization in dependability, such as thermal stability, and a high brightness field at coincidence by doping triplet luminescent material in an organic host ingredient, especially a disconjugation macromolecule.

[0009]

[Function] Light was not able to be effectively taken out from triplet luminescent material by molecules' being easy to meet, and moving to the excimer rhe in which formation of exciplex and the energy obtained by recombination are formed by pi conjugation macromolecules, if triplet luminescent material is doped into pi conjugation macromolecule which is easy to form an excimer. On the other hand, preferably, the thing with an organic host ingredient, especially a carbazole unit for which light is taken out effectively, without forming exciplex in a disconjugation macromolecule is possible, and brightness and luminous efficiency reached by 10 times the conventional component.

[0010]

[Embodiment of the Invention] The organic EL device of this invention has a hole impregnation electrode, an electron injection electrode, and the luminous layer that becomes inter-electrode [ these ] from an organic host ingredient and a dopant, and said organic materials are the polymeric materials of non-conjugated system, and said dopant is an organometallic complex in which phosphorescence luminescence from 3-fold term condition is possible, and contains the metal ion which belongs to the VIII group of the MENDEREEFU periodic table at least.

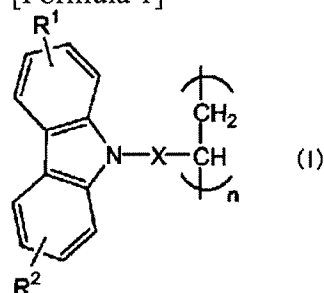
[0011] Thus, very efficient luminescence can be performed by doping the organometallic complex containing the metal ion which belongs to the organic host ingredient which forms a luminous layer at this using the polymeric materials of non-conjugated system which have a carbazole radical preferably to the VIII groups in whom phosphorescence luminescence from 3-fold term condition is possible.

[0012] What has charge transportability and has especially hole transportability as an organic host ingredient is desirable.

[0013] Moreover, as for especially these polymeric materials, it is desirable to have a carbazole radical. Specifically, the carbazole compound expressed with the following general formula (I) can be mentioned.

[0014]

[Formula 1]

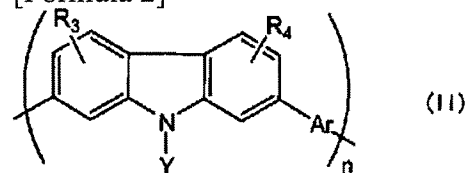


[0015] It sets at an above-mentioned ceremony (I), and is R1 and R2. Expressing hydrogen or the alkyl group of carbon numbers 1-18, X expresses the phenyl group of one to 3 ring, or an alkylene group. The molecular weight of the compound expressed with a formula (I) is Mw=10,000-100,000 preferably. R1 and R2 You may have the substituent further.

[0016] Moreover, you may be the carbazole compound expressed with the following type (II).

[0017]

[Formula 2]



[0018] It sets at an above-mentioned ceremony (II), and is R3 and R4. Hydrogen or the alkyl group of carbon numbers 1-18 is expressed, Y expresses the phenyl group, alkylene group, or xylylene radical of one to 3 ring, Ar expresses the phenyl group of one to 4 ring, and benzene, an anthracene, and its naphthacene derivative are especially desirable. R3

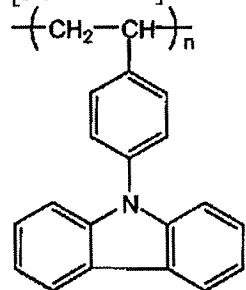
and R<sup>4</sup> And Y and Ar may have the substituent further, respectively.

[0019] Especially as a phenyl group expressed with X and Ar, the phenyl group of a monocycle is desirable.

[0020] The high molecular compound which has the repeat unit shown in the following formula especially as a non-conjugated-system polymer which is the organic host ingredient expressed with a formula (I) is desirable.

[0021]

[Formula 3]

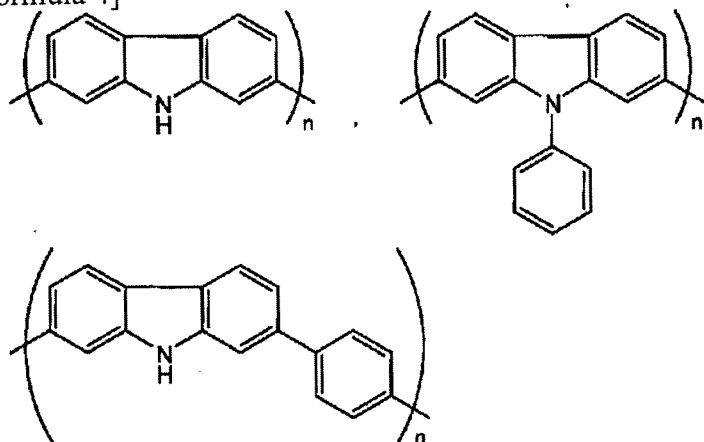


[0022] In the above-mentioned formula, it is Mw=10,000-100,000 preferably. The effectiveness can be further heightened by combining said metal complex with such non-conjugated-system polymeric materials.

[0023] Especially as an organic host ingredient expressed with a formula (II), what is shown below is desirable.

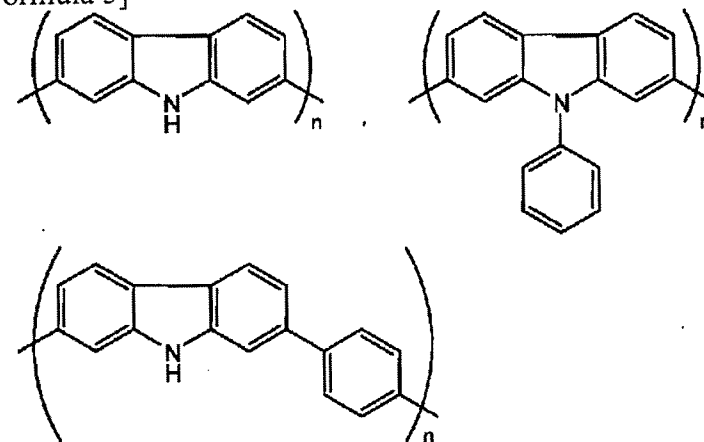
[0024]

[Formula 4]



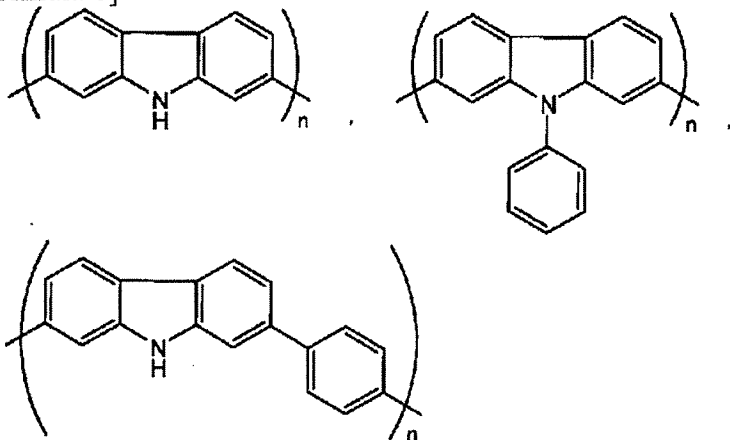
[0025]

[Formula 5]



[0026]

[Formula 6]



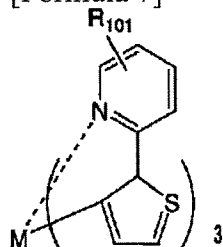
[0027] Such an energy gap  $E_g$  of an organic host ingredient 2.9-3.6eV or more is especially desirable 2.4eV or more.

[0028] In this invention, the compound in which phosphorescence luminescence is possible is doped from 3-fold term condition into the above-mentioned organic host ingredient. As an organic compound in which phosphorescence luminescence is possible, it is the organometallic complex in which 3-fold term condition to phosphorescence luminescence is possible, and they are Mendel's periodic table VIII group, i.e., the metal ion chosen from Fe, Co, nickel, Ru, Rh, Pd, Os, Ir, and Pt, and the metal complex which contains Ir or Pt ion preferably at least.

[0029] as such a metal complex -- as a ligand -- the following -- what is shown by [-izing 7] and [-izing 8] is desirable. In addition, although M expresses the above-mentioned central metal in the following formula and R101 and especially R102 are not limited, they are the alkyl group of carbon numbers 1-3, and an alkoxy group preferably.

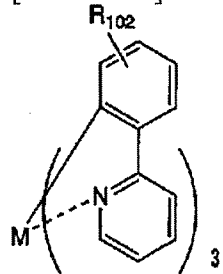
[0030]

[Formula 7]



[0031]

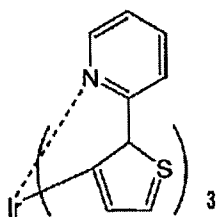
[Formula 8]



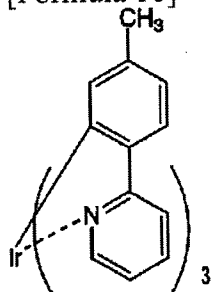
[0032] What is shown below, for example is mentioned as concrete structure of such a complex.

[0033]

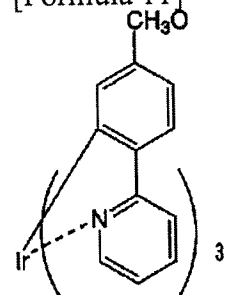
[Formula 9]



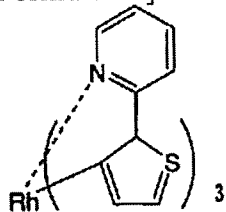
[0034]  
[Formula 10]



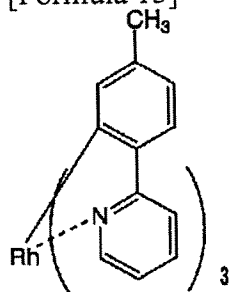
[0035]  
[Formula 11]



[0036]  
[Formula 12]

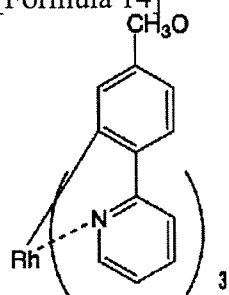


[0037]  
[Formula 13]



[0038]

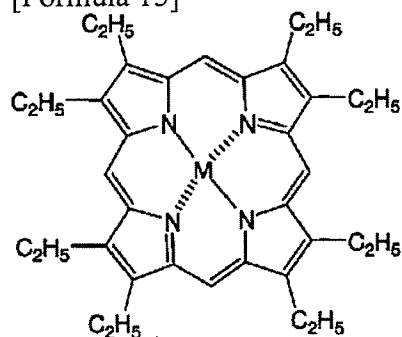
[Formula 14]



[0039] Moreover, the platinum complex (2, 3, 7, 8, 12, 13, 17, 18-Octaethyl-21H, and 23 H-porphine platinum) shown below is desirable, and its iridium complex:tris (2-phenyl pyridine) iridium [Ir (ppy)3] is desirable especially in these. In addition, in the following type, M expresses the above-mentioned central metal and especially its Pt is desirable.

[0040]

[Formula 15]



[0041] The content in the luminous layer of these metal complexes is 0.1 - 10 mol%, especially 1 - 10 mol% preferably to all components.

[0042] The above-mentioned organic host ingredients are charge transportability and an ingredient which has hole transportability preferably. When an organic host ingredient has hole transportability, an electronic transportability ingredient may be mixed to a luminous layer. Polymeric materials are sufficient although the low-molecular organic compound used for the conventional vacuum evaporation system is usable as an electronic transportability ingredient.

[0043] Specifically AlQ3 (tris (8-hydroxy-KINORINO) aluminum), BeQ2 (bis(8-hydroxy-KINORINO) beryllium), Zn (BOZ)2 (zinc-screw-benzoKISAZORU), Zn (BTZ)2 (zinc-screw-benzothiazole), Eu (DBM)3 (tris (1, 3-diphenyl -1, 3-propane JIONO) (mono-phenanthroline) europium (III)) (Phen), PBD (2-(4-biphenyl)- 5-(4-tert-buthylphenyl)- 1, 3, 4-OKISA diazole), Butyl-PBD (2-biphenyl-5-(Para-tert-buthylphenyl)- 1, 3, 4-OKISA diazole), One or more sorts, such as TAZ (1-phenyl-2-biphenyl-5-Para-tert-buthylphenyl - 1, 3, 4-triazole), can be mentioned.

[0044] The content of such an electronic transportability ingredient has ten to 50 mass %, especially desirable 20 - 40 mass % to all the components of a luminous layer.

[0045] The above-mentioned luminous layer may be formed independently and may consist of two or more layers. When it consists of two or more layers, the layer of hole transportability and the layer of electronic transportability may be formed separately. Moreover, said organic host ingredient or other components may have the concentration gradient in the direction of thickness. When it has the case where it has two or more layers, and a concentration gradient, it is good for an electronic transportability ingredient to exist in a cathode side, and to make it many hole transportability ingredients exist in a hole impregnation electrode side.

[0046] About the charge transportation ability of the ingredient used for a luminous layer, it is hold lift MOBIRI tea, 10<sup>-2</sup> - 10<sup>-5</sup> cm<sup>2</sup> / Vs is desirable, and they are more than 10<sup>-3</sup> cm<sup>2</sup> / Vs more preferably. Moreover, at room temperature dark conductivity, it is 10<sup>-11</sup> -10<sup>-9</sup> Scm<sup>-1</sup>. It is 10<sup>-10</sup> Scm<sup>-1</sup> preferably and more preferably. It is above.

[0047] The organic EL device of this invention may have the electrode interface improvement layer between the hole impregnation electrode and the above-mentioned luminous layer.

[0048] As an electrode interface reforming layer, the organic macromolecule layer containing poly dioxothiophene is

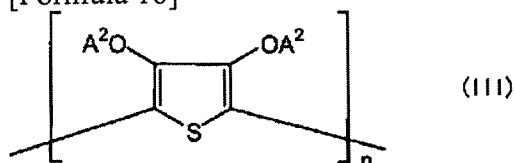


desirable.

[0049] The above-mentioned poly dioxothiophene contains the structural unit which is carrying out cation electrification under existence of the poly anion preferably, and is expressed with a formula (III).

[0050]

[Formula 16]

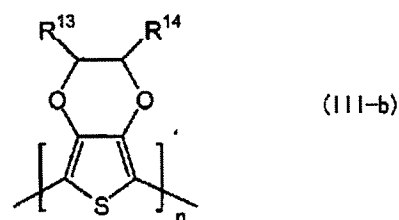
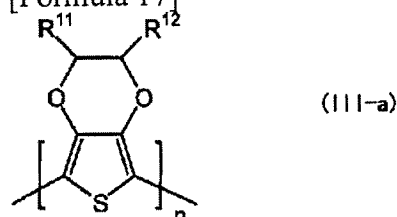


[0051] [-- or it carries out mutually-independent [ of A1 and A2 ] and expresses among a formula the alkyl group of the carbon numbers 1-14 which are not permuted [ each, a permutation, or ] -- or -- together -- becoming -- the alkylene of the carbon numbers 1-14 which are not permuted [ a permutation or ] -- forming -- \*\*\*\* -- and n -- 2 to 10,000, and] which expresses the integer of 5 to 5000 suitably

[0052] Suitable cationic poly dioxothiophene contains the following formula (IIIa) or (IIIb) the structural unit expressed.

[0053]

[Formula 17]

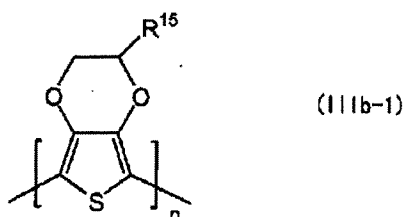
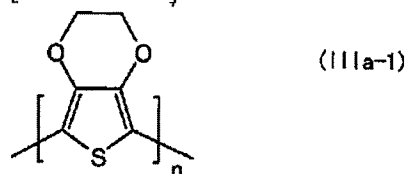


[0054] It carries out mutually-independent [ of R11 and R12 ] among [type. The alkyl group of the carbon numbers 1-18 which are not permuted [ hydrogen, a permutation, or ], Suitably The alkyl group of carbon numbers 1-10, especially carbon numbers 1-6, the alkenyl radical of carbon numbers 2-12, Suitably The alkenyl radical of carbon numbers 2-8, the cycloalkyl radical of carbon numbers 3-7, Suitably A cyclopentyl group or a cyclohexyl radical, the aralkyl radical of carbon numbers 7-15, Suitably The alkyl group of the phenyl-carbon numbers 1-4, the aryl group of carbon numbers 6-10, Suitably A phenyl group or a naphthyl group, the alkyloxy radical of carbon numbers 1-18, Suitably The alkyloxy radical of carbon numbers 1-10, for example, a methoxy group, an ethoxy radical, alkyloxy ester groups of carbon numbers 2-18, such as n- or an ISO-propoxy group, -- expressing -- R13 and R14 [ and ] The alkyl group of the carbon numbers 1-18 by which mutually-independent is carried out, hydrogen is expressed although both are not simultaneous, or each is permuted by at least one sulfonate radical, Suitably The alkyl group of carbon numbers 1-10, especially carbon numbers 1-6, the alkenyl radical of carbon numbers 2-12, Suitably The alkenyl radical of carbon numbers 2-8, the cycloalkyl radical of carbon numbers 3-7, Suitably A cyclopentyl group or a cyclohexyl radical, the aralkyl radical of carbon numbers 7-15, Suitably The alkyl group of the phenyl-carbon numbers 1-4, the aryl group of carbon numbers 6-10, Suitably Phenyl or a naphthyl group, the alkyloxy radical of carbon numbers 1-18, Expressing alkyloxy ester groups of carbon numbers 2-18, such as the alkyloxy radical of carbon numbers 1-10, for example, a methoxy group, an ethoxy radical, n-, or an ISO-propoxy group, suitably, n is 2 to 10,000, and] which expresses the number of 5 to 5000 suitably.

[0055] The following formula (IIIa-1), at least one sort of cationicity which are expressed, or the conductive compound which has not been charged is contained especially suitably.

[0056]

[Formula 18]



[0057] [-- R15 is synonymous with the above R13 and R14 among a formula, and n includes 2 to 10,000, and] electrochromic poly dioxythiophene which expresses the integer of 5 to 5000 suitably.

[0058] The above-mentioned poly anions are anions, such as anions, such as a giant-molecule carboxylic acid, for example, polyacrylic acid, Pori methacrylic acid, or a polymer lane acid, or a giant-molecule sulfonic acid, for example, polystyrene sulfonate, and a polyvinyl sulfonic acid. Such polycarboxylic acid and a polysulfone acid may be the copolymer made from a vinyl carboxylic acid and a vinyl sulfonic acid, other polymerization nature monomers, for example, acrylic ester, styrene, etc. again.

[0059] Especially the anion of polystyrene sulfonate is suitable as a counter ion.

[0060] the molecular weight of the polyacid which gives the above-mentioned poly anion -- suitable -- 1000 to 2,000,000 -- it is especially made 500,000 from 2000 suitably. Such polyacids or those alkali-metal salts, for example, polystyrene sulfonate, polyacrylic acid, etc. are commercially available, or can be prepared by the well-known approach (see after Houben-Weyl, Methoden der organischen Chemie, E 20-volume Makromolekulare Stoffe, PERT 2, (1987), and 1141 page).

[0061] It is also possible to use the mixture which consists of the alkali-metal salt of the above-mentioned polyacid and the mono-acid of a corresponding amount instead of being the isolation polyacid demanded when producing the distributed object of poly dioxythiophene and the poly anions.

[0062] The poly dioxythiophene in the case of a formula (III b-1) has positive charge and a negative charge in the structural unit. manufacture of such poly dioxythiophene -- for example, the European Patent application public presentation 0th -- it is described by 440 957 No. (= United States patent 5th 300 No. 575) etc.

[0063] Such poly dioxythiophene is obtained by the oxidation polymerization. Although they acquire positive charge as the result, since it is impossible, measuring those \*\* and locations clearly does not show it in the formula.

[0064] These high molecular compounds can be dissolved into a solvent, and can form a desired macromolecule layer on a substrate by spreading, casting, dipping, etc.

[0065] Especially as a solvent of these high molecular compounds, it is not limited, and a suitable thing can be chosen and used from the thing of a well-known ingredient. What is necessary is just to specifically use organic solvents, such as toluene, a xylene, and chloroform, alcohol, water, etc. properly with an ingredient.

[0066] In this invention, as a substrate which forms the organic electroluminescence structure, a crystal substrate, for example, Si, GaAs, ZnSe, ZnS, GaP, InP, etc. are raised, and an amorphous substrate, for example, glass, a quartz, etc. can also use for these crystal substrates a crystalline substance and the substrate in which the buffer layer of amorphous or a metal was formed. Moreover, as a metal substrate, Mo, aluminum, Pt, Ir, Au, Pd, etc. can be used, and a glass substrate is used preferably. When becoming an optical ejection side, as for a substrate, it is desirable to have the same light transmission nature as the following electrode.

[0067] As an electron injection electrode, the matter of a low work function is desirable, for example, in order to raise

metallic element simple substances, such as Cs, K, Li, Na, Mg, La, Ce, calcium, Sr, Ba, aluminum, Ag, In, Sn, Zn, and Zr, or stability, it is desirable to use the alloy system containing them of two components and three components. As an alloy system, Ag-Mg (Ag:0.1 - 50at%), aluminum-Li (Li:0.01 - 14at%), In-Mg (Mg:50 - 80at%), aluminum-calcium (calcium:0.01 - 20at%), LiF (F:40 - 60at%), etc. are desirable, for example. An electron injection electrode may be used also [ electrode / above-mentioned / wiring ], and may be formed separately. An electron injection electrode can be formed by vacuum deposition or the sputter.

[0068] What is necessary is just to set preferably 0.1nm or more of thickness of an electron injection electrode thin film to 1nm or more that what is necessary is just to consider as the thickness more than [ which can perform electron injection enough ] fixed. Moreover, although there is especially no limit in the upper limit, thickness is just usually about 1-500nm.

[0069] Since a hole impregnation electrode is a configuration which takes out the light which usually emitted light from the substrate side, transparence thru/or its translucent electrode are desirable. As a transparent electrode, although ITO (tin dope indium oxide), IZO (zinc dope indium oxide), ZnO, SnO<sub>2</sub>, and In<sub>2</sub>O<sub>3</sub> grade are mentioned, ITO (tin dope indium oxide) and IZO (zinc dope indium oxide) are preferably desirable. Although ITO usually contains In<sub>2</sub>O<sub>3</sub> and SnO with stoichiometric composition, some amounts of O may be deflected after this.

[0070] As for especially a hole impregnation electrode, it is desirable that a luminescence wavelength band and light transmittance [ especially usually as opposed to each luminescence light 350-800nm ] are 60% or more 50% or more. Usually, since it is taken out through a hole impregnation electrode, when the permeability becomes low, the luminescence from a luminous layer itself decreases luminescence light, and it has the inclination for brightness required as a light emitting device to no longer be obtained. However, when taking out luminescence light only from one side, the side to take out should just be more than the above.

[0071] The thickness of a hole impregnation electrode has [ that what is necessary is just to have the thickness more than / which can perform hole impregnation enough / fixed ] the preferably desirable range of 50-500nm and further 50-300nm. Moreover, although especially a limit does not have the upper limit, if not much thick, the worries about exfoliation etc. will arise. When thickness is too thin, there is a problem in respect of the film reinforcement at the time of manufacture, or hole transport capacity and resistance.

[0072] Although this hole impregnation electrode layer can be formed with vacuum deposition etc., forming by the sputter preferably is desirable.

[0073] Furthermore, in order to prevent the organic layer of a component, and oxidation of an electrode, it is desirable to close a component top with a closure plate etc. In order to prevent invasion of moisture, an adhesive resin layer is used for a closure plate, and it pastes up and seals a closure plate. closure gas -- Ar, helium, and N<sub>2</sub> etc. -- inert gas etc. is desirable. Moreover, the moisture content of this closure gas is 100 ppm. It is 10 ppm more preferably hereafter. It is 1 ppm especially hereafter. It is desirable that it is the following. Although there is especially no lower limit in this moisture content, it is usually 0.1 ppm. It is extent.

[0074] Especially glass is desirable, although it is plate-like preferably as an ingredient of a closure plate and the transparence thru/or translucent ingredient of glass, a quartz, resin, etc., etc. is mentioned. As such glass material, although the field of cost to alkali glass is desirable, the thing of glass presentations, such as soda lime glass, lead alkali glass, borosilicate glass, aluminosilicate glass, and silica glass, is also desirable. Glass material without surface treatment can use it cheaply with soda glass especially, and it is desirable. As a closure plate, a metal plate, a plastic sheet, etc. can also be used besides a glass plate.

[0075] A closure plate may adjust height using a spacer and may hold it in desired height. As an ingredient of a spacer, a resin bead, a silica bead, a glass bead, glass fiber, etc. are mentioned, and a glass bead etc. is especially desirable. In addition, when a crevice is formed in a closure plate, even if it uses it, it is not necessary to use a spacer.

[0076] It may be beforehand mixed into the adhesives for the closures, or a spacer may be mixed at the time of adhesion. the content of the spacer in the adhesives for the closures -- desirable -- 0.01 - 30wt% -- it is 0.1 - 5wt% more preferably.

[0077] Although the stable bond strength can be maintained as adhesives, and it is not limited especially if airtightness is good, it is desirable to use cation hardening type ultraviolet curing mold epoxy resin adhesive.

[0078] The luminescent color may be controlled using the color conversion film which contains the color filter film and the fluorescence matter in a substrate, or the dielectric reflective film.

[0079] What is necessary is to adjust the property of a color filter according to the light in which an organic EL device emits light, and just to optimize ejection effectiveness and color purity, although what is necessary is just to use for the color filter film the color filter used with the liquid crystal display etc.

[0080] Moreover, if the color filter which can cut the outdoor daylight of short wavelength in which an EL element ingredient and a fluorescence conversion layer carry out light absorption is used, the contrast of the lightfastness and a display of a component will also improve.

[0081] Moreover, it is good as for instead of a color filter using an optical thin film like dielectric multilayers.

[0082] Although the fluorescence conversion filter film is absorbing the light of EL luminescence and making light emit from the fluorescent substance in the fluorescence conversion film and performs color conversion of the luminescent color, it is formed from three, a binder, a fluorescence ingredient, and a light absorption ingredient, as a presentation.

[0083] As for a fluorescence ingredient, it is [ that what is necessary is just to use what has a high fluorescence quantum yield ] fundamentally desirable for absorption to be strong in EL luminescence wavelength region. What is necessary is in fact, for laser coloring matter etc. to be suitable and just to use a rhodamine system compound, a perylene system compound and a cyanine system compound, a phthalocyanine system compound (for subphthalocyanine etc. to be included) naphthalo imide system compound and a condensed-ring hydrocarbon system compound, a condensation heterocycle system compound, a styryl system compound, a coumarin system compound, etc.

[0084] As for a binder, what can perform detailed patterning in photolithography, printing, etc. is [ that what is necessary is just to choose an ingredient which does not quench fluorescence fundamentally ] desirable. Moreover, when formed in the condition of touching a hole impregnation electrode, on a substrate, an ingredient which does not receive a damage at the time of membrane formation of hole impregnation electrodes (ITO, IZO, etc.) is desirable.

[0085] When the light absorption of a fluorescence ingredient is insufficient, it uses, but when there is no need, it is not necessary to use a light absorption ingredient. Moreover, a light absorption ingredient should just choose an ingredient which does not quench the fluorescence of a fluorescence ingredient.

[0086] The organic EL device of this invention serves as a configuration of the order laminating where the laminating of substrate 1 / hole impregnation electrode 2 / electrode interface reforming layer 3 / luminous layer 4 / the electron injection electrode 5 was carried out one by one, as shown in drawing 1 . Moreover, what is necessary is to be good also as a reverse laminating which made this built-up sequence reverse, and just to consider as the optimal laminating configuration with engine performance, a specification, etc. which are demanded.

[0087] an organic EL device -- a direct-current drive -- a pulse drive is carried out and an alternating current drive is also possible. Applied voltage is usually 2-30V. It is extant.

[0088] The organic EL device of this invention can be used for various optical application devices, such as repeating installation in the transmission line of optical communication, the others, for example, the optical pickup which makes a note and is used for read-out/writing, as a display, and a photo coupler. [ application ]

[0089]

[Example] UV/O<sub>3</sub> after cleaning a <example 1> ITO substrate ultrasonically in order of neutral detergent, ultrapure water, an acetone, and ethanol It washed.

[0090] After forming 50nm [Poly(3,4-ethylenedioxythiophene)-polystyrenesulphonate (PEDOT/PSS)] of Pori (3,4-ethylene dioxothiophene)-polystyrene sulfonate by the SUPINKO \*\* method on an ITO substrate, the vacuum drying was carried out at 110 degrees C for 1 hour, and the hole impregnation electrode was created.

[0091] To the polyvinyl carbazole [Polyvinylcarbazole (PVK)] which is a hole transportability ingredient, as an electronic transportability ingredient Come out comparatively and it adds. 2-(4'-TERUTO-buthylphenyl)-5-(4'-biphenyl)-1,3, and 4-OKISA diazole [2-(4'-tert-Butylphenyl)-5-(4'-biphenyl)-1,3, and 4-oxadiazole] -- 30wt(s)% -- The iridium complex (Ir3 (ppy)) which is furthermore triplet luminescent material was doped at a rate of 1 mol%, and it was made to dissolve so that it may become the concentration of 20mg/ml at toluene. 100nm of this solution was formed by the SUPINKO \*\* method on the ITO substrate which formed PEDOT, the vacuum drying was carried out at 50 degrees C for 1 hour, and it considered as the luminous layer.

[0092] Subsequently, after fixing the substrate in vacuum devices and decompressing the inside of a tub below to  $1 \times 10^{-4}$  Pa, subsequently 100nm of aluminum was vapor-deposited, and 0.5nm of LiF(s) was used as the cathode of an

electron injection electrode and an auxiliary electrode.

[0093] The glass closure was made the last and the organic electroluminescence display was obtained.

[0094] When electric field were applied to this component by using aluminum as a cathode, having used ITO as the positive electrode, it is 10 mA/cm<sup>2</sup>. They are 2000 cd/m<sup>2</sup> at current density. Brightness was obtained. For the maximum current efficiency, 23 cd/A and the highest brightness are 25000 cd/m<sup>2</sup>. It reached.

[0095] The organic EL device was created like the example 1 except having used the polyvinyl triphenylamine [Polyvinyltriphenylamine] for the change of PVK as a <example 2> hole transportability ingredient.

[0096] At this component, they are 10 mA/cm<sup>2</sup>. They are 1500 cd/m<sup>2</sup> at current density. Brightness was obtained. For the maximum current efficiency, 15 cd/A and the highest brightness are 17000 cd/m<sup>2</sup>. It reached.

[0097] The same procedure as an example 1 performed membrane formation of the <example of a comparison> 1 PEDOT.

[0098] It is Ir (ppy)<sub>3</sub> so that it may become the concentration of 1 mol% all over [Pori Poly (9 and 9-dioctylfluorene)] (9 and 9-dioctyl fluorene) which is pi conjugation giant molecule. It added and dissolved in the chloroform solution. 100nm formed membranes with the spin coat method on the ITO substrate which formed PEDOT using this solution.

[0099] Subsequently, after fixing the substrate in vacuum devices and decompressing the inside of a layer below to 1x10<sup>-4</sup> Pa, subsequently 100nm of aluminum was vapor-deposited, and 0.5nm of LiF(s) was used as the cathode of an electron injection electrode and an auxiliary electrode.

[0100] The glass closure was made the last and the organic electroluminescence display was obtained.

[0101] this component -- Ir (ppy)<sub>3</sub> from -- although luminescence could also be checked, luminescence from exciplex with Pori (9 and 9-dioctyl fluorene) [Poly(9 and 9-dioctylfluorene)] was dominant. For this reason, 10 mA/cm<sup>2</sup> They are 100 cd/m<sup>2</sup> at current density. Only brightness is obtained but the highest brightness is also 2000 cd/m<sup>2</sup>. It is a low property.

[0102] The same procedure as an example 1 performed membrane formation of the <example of a comparison> 2 PEDOT.

[0103] As a luminous layer, it is Pori (2-methoxy, 5-(2'-ethyl - KUSAOKISHI)-1, 4-phenylenevinylene) [Poly (2-methoxy, 5-(2'-ethyl-hexoxy)-1, and 4-phenylenevinylene(MEH-PPV)] was used, and Ir (ppy)<sub>3</sub> was added by the concentration of 1 mol%). The xylene was used for the solution and 100nm formed membranes with the spin coat method.

[0104] Subsequently, after fixing the substrate in vacuum devices and decompressing the inside of a layer below to 1x10<sup>-4</sup> Pa, subsequently 100nm of aluminum was vapor-deposited, and 0.5nm of LiF(s) was used as the cathode of an electron injection electrode and an auxiliary electrode.

[0105] The glass closure was made the last and the organic electroluminescence display was obtained.

[0106] Ir (ppy)<sub>3</sub> since the band gap of MEH-PPV is low with this component energy transfer -- not happening -- Ir (ppy)<sub>3</sub> from -- luminescence was not able to be checked. Moreover, EL spectrum is not a thing from MEH-PPV, either, and is MEH-PPV and Ir(ppy)<sub>3</sub>. It was luminescence from exciplex. For this reason, 10 mA/cm<sup>2</sup> Only the brightness of 40 cd/m<sup>2</sup> is obtained with current density, but the highest brightness is also 250 cd/m<sup>2</sup>. It is a low property.

[0107] <Example 3 of a comparison> Ir<sub>3</sub> (ppy) Instead, the coumarin 6 [Coumaline6] was used for the doping ingredient, and also the EL element was created like the example 1.

[0108] The property of this component is 10 mA/cm<sup>2</sup>. They are 60 cd/m<sup>2</sup> at current density. Only brightness is obtained but the highest brightness is also 3000 cd/m<sup>2</sup>. It becomes a low property and is Ir (ppy)<sub>3</sub>. Compared with the used component, it has become 1/30 or less.

[0109]

[Effect of the Invention] According to this invention, the organic EL device which enables efficient-ization in dependability, such as thermal stability, and a high brightness field at coincidence is realizable as mentioned above by doping triplet luminescent material in polymeric materials, especially a disconjugation macromolecule.

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[Translation done.]

